Advanced Photon Source

APS Beamline Operations Policies and Procedures

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Approvals: approvals are recorded in the APS Document Management System (ICMS)

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The policy collects existing user safety policies and procedures and supersedes the individual policies and procedures.

There has been general editing for grammatical corrections, updates in organization/group names, and clarifications, without changes in substance.

Specific Changes: General Users (GU) have replaced Independent Investigators (II). Science Advisory Committee (SAC) has replaced the Program Evaluation Board (PEB). APS Engineering Services Division (AES) replaces the Operations Division (AOD). Named references to the User Technical Interface have been replaced with the title. APS organizational references updated in the Vacuum policy. Introduction added.

Table of Contents

APS Beamline Operations Policies and Procedures 3
  Introduction 3
  Purpose 3
  Scope 3
  Applicability 3
Storage Ring Access for Emergency Repairs 4
  Policy 4
Initiation of General User Programs by Collaborative Access Teams 5
  Policy 5
  Procedure 5
Use of Third-Party Contractors at the APS 6
  Policy 6
  Procedure 7
  Responsibilities 7
Installations and Modifications of Permanent Structures in the APS Experiment Hall and LOMs 8
  Policy 8
  Procedure 8
Installing Equipment on the Roof of a Radiation Enclosure and/or Installing a Ladder to Reach Such Equipment 9
  Policy 9
  Procedure 9
Experiment Hall Free of Obstruction above 15' 11
  Policy 11
Vacuum Policy for APS Beamlines 12
  1. Introduction 12
1.1 Purpose 12
1.2 Scope 12
1.3 Definitions 13
1.4 References 15
  2. Beamline Vacuum Design 15
  3. Interlocks and Equipment Protection Systems 16
  4. Beamline Vacuum Equipment 17
  5. Vacuum Design Approval 18
  6. Requirements for Integrating the Beamline and Front-End Vacuum 18
  7. Vacuum Policy Summary 19
Requirements for front-end differential pump installation 20
  Procedure 20

APS Beamline Operations Policies and Procedures

Introduction

The APS has site-specific ESH processes that cover both non-user and user activities. APS User Policies and Procedures are the APS-specific implementation of Argonne environmental, safety, and health (ESH) requirements that focus on, or are unique to, user activities. The APS User Policy and Procedures document is divided into four sections:

- APS Procedure 3.1.101 – User Administration
- APS Procedure 3.1.102 – User Safety
- APS Procedure 3.1.103 – User Training
- APS Procedure 3.1.104 – Beamline Operations (this document)

The owner of the APS Beamline Operations section of APS User Policies and Procedures is the APS User Technical Interface. The owner shall work with the APS Procedure Administrators to keep the current version available in ICMS.

Changes to this document shall be managed according to Managing APS Facility Procedures (APS Procedure 3.1.05, ICMS APS_1001409).

Anyone using this document shall ensure that they are using the current version.

Purpose

APS Beamline Operations Policies and Procedures define planning and work processes, for user-related activities, that help protect the APS facilities and the health and safety of workers, the environment, and the public.

Scope

The policies and procedures defined in APS Beamline Operations Policies and Procedures cover requirements relevant to the operation and management of APS beamlines and beamline support facilities.

The following topics are covered by other APS Policies and Procedures:

- User Administration (APS Procedure 3.1.101)
- User Safety (APS Procedure 3.1.102)
- User Training (APS Procedure 3.1.103)

Applicability

APS User Policies and Procedures apply to the activities of beamline personnel, experimenters, and other support personnel using CAT/CDT/XOR beamlines and associated facilities (e.g., LOM labs). These apply to users that are not Argonne employees as well as Argonne employees.

Storage Ring Access for Emergency Repairs

(Formerly APS Technical Update - No. 31 (Revised), AP&P 3.1.27, APS_1187358)

Policy

If an ID or front-end fault prevents a beamline from conducting normal operations, but has no operational impact on the storage ring or presents no safety implications to the facility or personnel, any access to the ring to diagnose and repair the fault will be made under the following conditions:

1. If there is a machine intervention period planned within 72 hours of the time the fault occurs, then any access will occur during the machine intervention period.
2. If there is not a machine intervention period within 72 hours of the fault, then beamline personnel, having demonstrated a significant scientific impact due to the fault, may request an access starting at 4:00 a.m. with exit from the tunnel at a time that will allow beam injection by 7:00 a.m. Such a request must be made by noon on the day prior to the access. If the problem is well understood and the APS agrees that a three-hour intervention period is sufficient to solve the problem, then, upon approval, the APS will notify users of the access by 3:00 p.m. of the day prior to the access and the work will be coordinated at the daily 4:00 p.m. MCR meeting.
3. The AES Director or designee will review and approve all such repair requests.

Initiation of General User Programs by Collaborative Access Teams

Policy

A Collaborative Access Team (CAT) is expected to begin allocating beam time on a given experimental station to General Users (GUs) no later than one year after the CAT Director designates the station as operational. A station is considered "operational" when:

(a) shielding and PSS validations of the station(s) are successfully complete;
(b) installation and commissioning of the instruments specified for the station(s) in the Final Design Report are successfully complete; and
(c) the scientific capabilities of the station(s) have been demonstrated.

A CAT may, at its discretion, begin allocating beam time to GUs after a shorter interval.

The "Approval to Operate" date for a given beamline is defined as the date of the first designation of an operational station on that beamline.

Procedure

The CAT Director or designee will:

1. Develop and present a timeline for designation of its station(s) as operational to the APS Scientific Advisory Committee (SAC);
1. Notify the APS User Office when the CAT Director designates a given experimental station as operational in accordance with the plan it has presented to the SAC;
2. Submit a GU access plan to the APS User Office for review within three months after making its first designation of an operational station, or nine months before the GU program is to begin;
3. Announce the program and the availability of GU beam time upon final approval of the GU access plan (the GU access plan is expected to be in final approval status six months before the GU program is to begin);
4. Submit a written justification to the APS at least three months before the one-year limit is reached in cases where it is necessary to delay the initiation of the GU program on a given station beyond the one-year limit, e.g., due to an unexpected occurrence. The APS may refer this justification to the SAC for evaluation and recommendations.

Use of Third-Party Contractors at the APS

(Formerly APS Technical Update No. 22)

Policy

Training Requirements for Contractors

1. The APS will make licensed and qualified electricians, pipefitters, carpenters, and other "skilled trade" workers available to APS Users for those beamline construction and installation tasks (hutch installation, electrical distribution, pipefitting, etc.) that require these types of workers and for any other tasks that Users wish to have done by such workers. User institutions may not contract directly with contractors for any construction work on the APS site. Two mechanisms are in place to provide assistance with construction work: Contract Construction and Time-and-Materials (T&M) Construction using a Service Request Order (SRO). Examples of construction work include:

   - Changes to the physical plant, including any drilling into floors, walls, or ceilings, or altering of any permanent structure.
   - Use of industrial lifts, scaffolds, or cranes.
   - "Hard-wire" installation or tie-in to facility utilities, including electrical, plumbing, ventilation, or water systems.

2. The APS will routinely permit purchase orders or other agreements between User institutions and third parties for work at the APS site by the third party, if the User institution has signed an APS User Agreement or a contract to operate an APS beamline, and if the scope is limited to the following types of work:

   - Installation work that is incidental to the User institution's purchase of a piece of technical equipment (goniometer, computer, mirror, vacuum chamber, etc.) and which does not require construction activities (hutch installation, electrical distribution, pipefitting, etc.) to be performed by the third-party contractor.

   OR

   - Installation, maintenance, or repair of User-owned equipment (such as repairing a fax machine, assembling furniture, or calibrating an instrument).

   The User will be responsible for ensuring that each approved third party complies with the provisions of the Collaborative Access Team (CAT) Safety Plan while working at the APS.

3. The contractor will use ANL rigging services if the work involves the use of a rider-operated forklift.

Procedure

The requestor shall:

1. complete Part 1 of an "APS Work/Project Checklist" (Form UO-38) and submit it to an APS Floor Coordinator; or
2. if the work is T&M construction, complete an SRO (Form UO-03) in place of Form UO-38 and submit it to an APS Floor Coordinator.

The Floor Coordinator receiving form UO-38 or UO-03 from the requestor shall:

1. review the scope of the work;
2. refer any questions to APS Procurement for resolution;
3. determine which of the three methods shown below will be used:
   - If the requested work is T&M Construction, the Floor Coordinator will forward the completed SRO to the APS Engineering Support Division (AES) Technical Representative. AES personnel will manage the T&M activity. Work records are available for CAT review through the Floor Coordinator.

     OR
   - If the requested work is construction, other than T&M construction, the effort must be carried out under the provisions of an ANL contract requested by the APS Conventional Facilities Group.

     OR
   - If the requested work is determined not to be construction, the Floor Coordinator will deliver the request to the AES ES&H Coordinator for determination of the job safety requirements.
4. work with the CAT and the AES ES&H Coordinator to ensure completion of all work entry requirements;
5. arrange for gate passes, safety training, and dosimeters, if applicable, for the contractor.

The contractor shall:

1. complete all necessary training;
2. proceed with the work under CAT and APS oversight.

Responsibilities

The CAT has the primary responsibility for service contract work.

The APS has the primary responsibility for construction activities.

Installations and Modifications of Permanent Structures in the APS Experiment Hall and LOMs

Policy

Prior APS approval is required for all installations and modifications of permanent structures in the APS Experiment Hall and LOMs, including those installations and modifications that are financed by APS Users.

Procedure

1. The approval process for initial LOM buildouts is described in *Guide to the Construction Process for CAT Laboratory/Office Modules*, rev. 1, March 20, 1996.

2. The approval process for installation of beamlines is described in *APS Beamline Design and Construction Requirements, a Reference Manual for Designers and Builders*, ANL/APS/TB-14, May 1994.

3. If a CAT desires an installation or modification of a permanent structure that has not been explicitly approved via one of the above-mentioned processes, the CAT will submit its design, its implementation plan, and a written programmatic justification to the User Technical Interface (UTI).

4. The UTI or designee will arrange for all necessary technical and safety reviews of the design, and the CAT will refine the design as needed to produce a final design that is acceptable to the APS.

Installing Equipment on the Roof of a Radiation Enclosure and/or Installing a Ladder to Reach Such Equipment

(Formerly APS Technical Update - No. 12 – Updated October 4, 2007)

Policy

Each APS radiation enclosure is unique, therefore specific data are required to analyze the programmatic and safety requirements for each proposed installation of equipment, or installation of a ladder to allow access to equipment, on the roof of a radiation enclosure.

The procedure below is designed to generate the data required for the analysis. They questions were compiled with the following considerations in mind:

- **Use of ladders**: There are significant hazards associated with the use of vertical ladders to access the roofs of enclosures; in general, vertical ladders are inappropriate if the climber is carrying anything, including notebooks, tools, or equipment. Alternatives include scissor lifts and movable stairs that become fixed when loaded with the weight of a person.
- **Working at elevations:** Fall protection must be provided for any person(s) working on the roof of an enclosure.
- **ALARA practices**: In the standard specifications of the shielding for the enclosures, a low rate of occupancy on the enclosure roofs was assumed, and the thickness of the lead in the roof panels was reduced accordingly.
- **Loads on station roofs**: Designs for ladders, gangways, railings, etc., must meet applicable safety standards. The floor space around the enclosure must be adequate for the installation.

Procedure

The requestor shall:

1. submit answers to the following questions, along with a description of the proposed installation, to the AES Division Director for review and approval.
   - What is the justification for this installation?
   - What is the weight of the equipment to be installed?
   - What is the electrical power requirement to operate the equipment?
   - What other utilities (DI water, chilled water, pressurized air, etc.) are required to operate the equipment?
   - Does the installation require addition of a penetration and labyrinth into the enclosure?
   - Does an exhaust vent need to be connected to the equipment?
   - Where will the discharge from the exhaust go?
   - What, if any, hazards are associated with the exhaust gases?
   - Will the equipment be connected to the beamline EPS?
   - What degree of vibration and/or noise will be generated when the equipment is in operation?
   - How often will access to the equipment be needed?

- What is the expected duration of each access period?
- How many persons will be on the roof of the enclosure simultaneously to use/maintain the equipment?
- What tools and other items will need to be carried to the roof of the enclosure to use/maintain the equipment?
- What is the height of the enclosure?
- Is there adequate room around the enclosure to accommodate an installed ladder plus the surrounding space required for personnel access and egress?
- What mechanism will be used to control access to the ladder and the equipment by untrained persons?
- Does the approved Beamline Safety Document adequately cover the hazards that may result from this installation?

The AES Division Director or designee shall:

2. Review the proposed installation per the APS Design Review Procedure (AP&P 3.1.01, ICMS APS_000031).

Experiment Hall Free of Obstruction above 15'

(Formerly APS Technical Update - No. 14)

Policy

The APS requires access to facilities on the Experiment Hall ceiling for routine maintenance, such as changing light bulbs, maintaining HVAC blowers and filters, and the repair of utilities systems. The APS seeks to minimize the impact on beamline operations of these maintenance activities. As floor space within a sector is at a premium, a variety of means will be required to gain access to the ceiling including: access from the sector-dividing aisles, the top of the experimental stations, the top of the storage ring shielding, and the floor within the sectors.

In order to permit the use of man lifts that can be maneuvered above the beamline facilities, the airspace above these areas needs to remain free of obstructions. Towards this end, users should keep in mind the following design/installation criteria:

In the APS Experiment Hall, the airspace between 15' and 21' above the Experiment Hall floor is to remain free of obstructions. This will provide enough elevation for a worker on a man lift to work below the facilities mounted on the Experiment Hall ceiling. Any installation that intrudes into the space above the 15' elevation requires APS approval. Inquires are to be directed to the APS User Technical Interface. As a reminder, all permanent installations at the APS require review and approval.

Vacuum Policy for APS Beamlines

(Formerly AP&P 3.1.08, Revision: 3 - supersedes revision dated 11 October 2004, APS document number APS_1186209)

1. Introduction

1.1 Purpose

The lifetime and stability of the electron beam within the APS storage ring requires that the pressure within the storage-ring and the front-end vacuum chambers be maintained as low as possible and that contamination, which would affect the vacuum or jeopardize the effectiveness of the vacuum pumping, be minimized. Because the beamline vacuum can affect, either directly or through an accident, the front-end and storage-ring vacuum and other aspects of the operation of the facility, the APS has established the policy specified in this document for beamline vacuum designs. If the beamline design cannot comply with requirements as stated in this policy, variances will be reviewed and approved on a case-by-case basis upon written request to the APS User Technical Interface.

1.2 Scope

This policy applies to all x-ray beamlines and is to be complied with by beamline designers, builders, and users. This policy states the minimum *requirements* to be met and the *recommendations* to be followed to ensure that beamline vacuum conditions will not affect facility operation. This policy remains in effect and encompasses the facility operating conditions expected through commissioning and beyond. This policy will be modified as operating conditions and/or requirements change.

There are other design requirements that are closely related to the vacuum policy, such as those related to radiation shielding and ozone abatement, and these should be addressed in the development of the beamline vacuum design. This policy is based upon the required vacuum conditions at the front-end to beamline interface and the required vacuum barriers that isolate the beamline from the front end rather than on generalized beamline transport vacuum specifications (i.e., vacuum conditions in each beamline transport segment are not specified).

Compliance

Beamline designs shall comply with the requirements stated in this policy. It is expected that technical and scientific needs of the beamline might require deviations in the beamline vacuum design from those required by the policy. These special needs should be brought to the attention of the APS as early as possible and also at the time of beamline design reviews. After a risk analysis is performed, the beamline will work with the APS towards an appropriate solution.

The beamline management will ensure that beamline members and General Users comply with the vacuum policy during beamline operations.

1.3 Definitions

1.3.1 Vacuum Level Specifications

In the following specifications, *beamline* and *beamline section* refer to any portion of a beamline located on the APS Experiment Hall floor, and the interlock level thresholds are the values for design and operation.

Ultra-High Vacuum (UHV)

A UHV beamline section will have vacuum interlock levels set at $\leq 1 \times 10^{-8}$ torr and will be constructed of UHV-compatible materials. Ultrahigh vacuum sections will be all metal (with the exception of Viton-sealed gate valves) and will have no in-vacuum, liquid-coolant joints within the vacuum envelope.

High Vacuum (HV)

A HV beamline section will have vacuum interlock levels set at $\leq 1 \times 10^{-6}$ torr and will be constructed of HV-compatible materials.

High Vacuum with No In-Vacuum, Liquid-Coolant Joints (HV)*

A HV* beamline section is the special case of an HV section that will have no in-vacuum, coolant (except liquid nitrogen) joints within the vacuum envelope.

Medium Vacuum (MV)

A MV beamline section will have vacuum interlock levels set at 1×10^{-3} torr.

1.3.2 Front End

The beamline front end provides the UHV transition from the APS storage ring through the ratchet wall to the portions of the beamline located on the APS Experiment Hall floor. Most of the front end is located within the storage-ring shielding tunnel. The front end is terminated by a window assembly or in the case of a differentially pumped front end, by a Beamline Isolation Valve (BIV), located outside the storage-ring shielding tunnel, which provides some degree of vacuum isolation between the beamline and the rest of the front end and the storage ring. The front end is installed and maintained by the APS.

Following installation, the front end will be terminated with a Be window assembly. Once reliable operation has been established, the beamline may request to exchange the Be window termination for a differential pump equipped with a residual gas analyzer head (RGA) or another window suitable for user needs.

1.3.3 Beamline Vacuum Partitions

1.3.3.1 Windows and Barriers

Beryllium Window

In a beamline on the APS Experiment Hall floor, it may be necessary to have sections with different vacuum requirements. Such sections may be terminated by having a beryllium window as the barrier. A beryllium window, for the purpose of this policy, must be made of beryllium that is at least 250 μm thick and must be able to withstand a pressure differential of more than 900 torr.

1.3.3.2 APS Front-End Terminations

1) Bending-Magnet Terminations

For the APS bending-magnet beamlines, the following window design will be used:

Front-end window assembly, typically with a 8.8 mm x 145 mm aperture, consisting of two Be windows, each with a thickness of 250 μm, separated by a vacuum space with independent pumping.

2) Wiggler Terminations

For the APS wiggler beamlines, the following window design will be used:

Wiggler front-end window assembly, filter protected, typically with a 8.8 mm x 72 mm aperture, consisting of two Be windows, each with a thickness of 250 μm, separated by a vacuum space with independent pumping.

3) Undulator Terminations

a) A front-end, double beryllium window with an integral fixed mask, typically with a 4.5 mm x 4.5 mm aperture and power filters for protection of the window. Each piece of beryllium is 250 μm thick and the space between them is under vacuum maintained with independent pumping.

b) A window consisting of an integral mask, typically with a 2x3 mm, or smaller, aperture followed by a single piece of Berylium, 500 μm thick, when approved by the AES Mechanical Operations and Maintenance group.

4) Differential pumps

Differential pumps may be used on the beamlines to separate the front end from the rest of the beamline. Differential pumps are made up of one or more vacuum chambers containing ion pumps and separated by apertures to maintain a pressure at the upstream end of less than or equal to 10^{-9} torr. The beamline must equip the downstream side of the undulator differential pump with an APS-specified residual gas analyzer (beamline RGA) head that will be monitored by the APS. The beamline will also provide a beamline inline gate valve (BIV) to isolate the differential pump. It is preferred that installation and operation of the BIV valve will be the responsibility of AES. This is not mandatory however. After the beamline personnel have gained some experience operating the beamline successfully with a window, windowless operation using a differential pumping station may be allowed. The beamline personnel can integrate the BIV valve into their beamline operations, or AES will integrate the BIV valve into the beamline front end operations.

1.3.4 White and Monochromatic Beam

White Beam

An x-ray beam whose spectral characteristics have not been modified from those produced by an insertion device or bending-magnet source, except through the introduction of filters, is referred to as white beam in this document. In addition, for the purpose of this vacuum policy, the term white beam includes beams that have been reflected from a mirror, but are not monochromatic (see next paragraph).

Monochromatic Beam

In this document, a monochromatic beam is an x-ray beam whose spectral characteristics have been defined by a monochromator to select an energy, along with its harmonics, and with a relatively narrow bandwidth, typically much less than a few percent. Again, this definition is used only for the purpose of this vacuum policy.

1.4 References

Vacuum Technology, A. Roth, Elsevier Sciences Publishers, 1990 (3rd Edition).

High-Vacuum Technology, Marsbed H. Hablanian, Marcel Dekker, Inc., 1990.

Theory and Practice of Vacuum Technology, Max Wutz, Hermann Adam and Wilhelm Walcher, Friedr. Vieweg & Sohn, 1989.

Advanced Photon Source Accelerator Ultrahigh Vacuum Guide, C. Liu and J. Noonan, ANL/APS/TB-16, 1994.

2. Beamline Vacuum Design

To ensure the protection of the APS storage ring and the beamline front ends, the APS requires that the following simple rules be followed.

2.1 General Rules for Beamline Vacuum Design

- Vacuum is required on the beamline side of the APS front-end/beamline interface.
  - If the front end is equipped with a standard beryllium window (2 x 250 μm or 1 x 500 μm), then a minimum of medium vacuum (MV) is required on the beamline side of the window.
  - If the front end is equipped with a differential pump, then 1) UHV or HV* is required on the beamline side of the differential pump, 2) the differential pump is isolated from the beamline by a beamline supplied gate valve (BIV), and 3) the beamline vacuum will be monitored by the APS using a UHV nude ion gauge and the RGA.
- For beamlines in which the white beam will be propagated in atmosphere, a minimum of two beryllium windows are required to isolate the front end from atmosphere. Each window must be at least 250 microns thick.
- For beamlines in which white beam is to be brought out of the beamline vacuum, the downstream beryllium window must be protected from oxidation with an additional window (for example Diamond, Kapton, Aluminum, etc.)

- At least one beryllium window, with a minimum thickness of 250 microns, is required to isolate beamline sections with medium vacuum or with in-vacuum, liquid-coolant joint.

2.2 Operation of APS Beamlines Using a Window

In general, beamline windows provide additional integrity in the vacuum design of the beamline, may ease the constraints of vacuum design, and simplify some beamline operations. Where consistent with the scientific objectives of the beamline, especially at higher energies where the reduction in flux through the window will be less, the APS encourages the use of windows to enhance the protection of the front end and storage ring, as well as beamline components.

2.3 Windowless Operation

Normally, windowless operation will only be permitted after a beamline has been operated successfully with a window. If the beamline is permitted to operate without a window, the existing window will be replaced by a standard differential pump. The section of beamline downstream of the differential pump and upstream of a window must be either UHV or HV* and be free of quick-couple style flanges. The APS will use the front-end RGA and a beamline supplied beamline RGA and nude ion gauge to monitor the vacuum conditions at the differential pump to beamline interface and in the front end. The beamline RGA spectrum must be equal to UHV or HV* defined pressure, or better, and be consistent with a contamination free vacuum in order to open the beamline supplied BIV valve.

In windowless operation, the RGA spectrum must be consistent with a contamination-free vacuum. Specifically, the residual gases should be hydrogen (M=2), methane (M=12 to 16), water (M=16 to 18), nitrogen (M=14, and 28), carbon monoxide (M=28) and carbon dioxide (M=44). In unbaked systems, the predominate peaks will be at M=2, 18, and 28. In baked systems, the predominate peaks will be at M=2, 16, 18, 28, and 44. If the RGA spectrum includes M=40 (argon) or M=32 (oxygen), this indicates that the system probably has a leak. Because the halides, chlorine and fluorine (M=19, 35, or 37), will poison NEG pumping strips, the windowless beamline spectrum must be free of these gases prior to opening the front-end exit valve. If the spectrum includes peaks at M=39, 41, 55, and 57, the beamline is probably contaminated by organic material and a peak at M=36 indicates that hydrogen sulfide is present. For windowless operation, the front-end exit valve will be opened only after the RGA test described in Section 6 has been passed.

3. Interlocks and Equipment Protection Systems

The front end contains a storage-ring isolation valve, a slow vacuum valve, a fast vacuum valve, a pair of pneumatically actuated photon shutters, two bremstrahlung shields and several aperture defining masks, and the front-end exit valve. In addition there is a Beamline Isolation Valve (BIV) for beamlines with differential pumps rather than windows as the front end to beamline transition. The APS has designed an equipment protection system (EPS) for the front end, which interfaces with the storage-ring equipment protection system. The APS will specify which interlocks are required as part of the beamline EPS system.

A fast-valve sensor is located directly downstream of the shield wall and is provided to protect the storage ring and the front end in the event of a catastrophic beamline vacuum failure and *vice versa*. In case of an accidental break in the beamline vacuum system resulting in a fast-valve trip, the front-end shutters, the slow valve, and the front-end exit valve will close as will the fast valve. In all cases a fast valve trip will dump the stored beam in the ring.

If a slow pressure increase is detected in the front end, resulting from a slow leak or pump failure, the front-end shutters, the slow valve, and the front-end exit valve will close and seal. PS1 will close to protect the slow valve.

Only an authorized APS staff member can open any of the front-end valves. The APS will define the specific procedure that must be followed to return the beamline to operation.

The APS recommends a beamline protection system to monitor vacuum conditions of the beamline. In order to reduce spurious vacuum trips of the beamline, or the front-ends, polling logic on the ion pump set points is recommended.

Note that the vacuum conditions in beam transports must be consistent with their shielding. The shielding specifications for transport provided in ANL/APS/TB-7 Section 4.3 are for evacuated transport. Other non-evacuated conditions, such as He-filled transport, are considered special cases and must be addressed on a case-by-case basis. The user should refer to TB-7 for additional guidance.

4. Beamline Vacuum Equipment

4.1 Vacuum Pumps

Because of concerns about noise and vibration on the APS Experiment Hall floor, it is preferred that ion pumps be used on beamline transports.

Sputter-ion pumps, titanium sublimation pumps, cryo-pumps, “oil-free” turbomolecular pumps, and NEG pumps are permitted as primary pumps in the UHV and HV* sections of beamlines. The cryo- and turbo-pumps must be equipped with appropriately interlocked isolation valves for beamline protection in case of a pressure and/or power failure.

During bakeout or rough pumping of the beamline or at the experiment stations, properly backed turbo-pumps, sorption pumps, or any other pumps approved by the APS may be used. When these pumps are used at an experiment station or a first optics enclosure, they must be equipped with appropriate interlocks and isolation valves to protect the vacuum system in case of a pressure rise and/or power failure. Because of potential beamline vacuum contamination and pump exhaust problems, it is required that oil-free mechanical pumps be used as backing or roughing pumps on all sections of beamlines and experimental equipment.

Diffusion pumps are not permitted for beamline pumping.

4.2 Gauges

For safety reasons, glass ionization gauges are *not permitted* in any sections of APS beamlines. Nude ionization gauges or cold cathode gauges are recommended. Penning gauges are particularly attractive because of their wide range (from 10^{-3} to 10^{-11} torr). When cold cathode or ionization gauges are operated, the vacuum chamber must be electrically grounded to the ion-gauge controller ground. Proper grounding is mandatory to eliminate the potential of high voltages on vacuum-system components. The collector cable must be safely shielded. The beamline personnel will be responsible for ensuring and demonstrating to the APS that the components are properly grounded and shielded.

5. Vacuum Design Approval

Beamline personnel will be responsible for the vacuum design and will ensure that the quality of the storage-ring vacuum is not degraded during the beamline operation. The latter can be achieved by following the APS beamline vacuum policy stated in this document. Beamlines are required to submit vacuum-design-related information as a part of the material for the beamline design reviews. Planned in-vacuum, liquid-coolant joints should be identified in the beamline design reports. It is also required that the beamlines meet the performance tests outlined in Section 6 for integrating the beamline vacuum with that of the front end.

6. Requirements for Integrating the Beamline and Front-End Vacuum

After any part of the beamline is brought up to air (or preferably to dry nitrogen) at ambient pressure or after its closure due to the detection of a vacuum fault, the following conditions must be satisfied before the front-end exit valve is opened:

1. The pressure at the front-end/beamline interface must be less than or equal to:
   - 10^{-3} torr if the front end is terminated with a double beryllium window, or
   - 10^{-6} torr if the front end is terminated with a differential pump with a monitored RGA, without in-vacuum, liquid-coolant joints within the vacuum envelope.

2. In windowless operation, the residual gas spectral analysis is performed using the RGA located on the downstream end of the differential pump. The residual gas spectrum must be consistent with a contamination-free vacuum. It must indicate that the sum of the M >= 46 components is <=1 x 10^{-9} torr. It must also show that the partial pressure of each component with masses corresponding to M equal to 19, 35, 37, 39, 41, 55, and 57 must be <= 5×10^{-11} torr.

3. Prior to startup of a beamline configured with or without a window or a new experiment in which the experimental sample shares the beamline vacuum, the user must demonstrate to the APS Floor Coordinator that all the vacuum interlocks in the UHV and HV* parts of the beamlines and equipment chambers are operational, that pumps are properly vented and equipped with appropriate isolation valves to protect

the vacuum in case of overpressure and/or power failures, and that adequate measures have been provided to protect the front-end and storage-ring vacuum from an accidental break in the vacuum system of the beamline on the Experiment Hall floor.

If the beamline is to be vented so as to no longer meet the vacuum requirements at the front termination, then the front-end slow valve and the front-end exit valve must be closed. On differential pump terminated beamlines, the valve between the beamline and the differential pump shall be closed prior to venting the beamline and shall remain closed until a RGA scan has shown the beamline vacuum to be contamination free.

7. Vacuum Policy Summary

FE to Beamline Transition

Transition Barrier	Vacuum requirement	
Differential Pump	UHV or HV*	RGA and Gate Valve Required
Be Window	UHV, HV*, HV or MV	

Other Considerations

Vacuum transition	A single Be Window
Mono beam transition to atmosphere	A minimum of two windows. UHV or HV* beamlines with a differential pump may have a single window to atmosphere
White beam transition to atmosphere	A minimum of two windows. The final Be window must have oxidation prevention. For example a downstream Diamond, Kapton or Aluminum window with the intervening volume either pumped or flushed with Helium
Beamline venting	At least one enclosed buffer zone, requiring two downstream valves to be closed

Requirements for front-end differential pump installation

(Formerly APS Technical Update - No. 20 Updated October 4, 2007)

Procedure

The Requestor shall:

1. Submit a request to the AES-DD for the installation;
2. Confirm that the beamline meets the requirements of the APS vacuum policy and that there will be no in-vacuum coolant (except liquid nitrogen) joints within the vacuum envelope;
3. Supply a gate valve to isolate the differential pump from the beamline;
4. Supply an RGA for the APS to monitor the beamline vacuum. The RGA is to be installed downstream of the provided gate valve in order that the quality of the beamline vacuum can be measured prior to opening the valve. Contact the AES-MOM for appropriate RGA ordering information.
5. Provide a minimum of three months advance notice and a schedule of when the replacement can take place.

Any improvements or corrections to this procedure may be submitted here
(http://www.aps.anl.gov/Internal/Policies_and_Procedures/comment_form.php)